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Country Economics Department
The World Bank
September 1990
WPS 504

Applying Tax Policy Models in Country Economic Work

Bangladesh, China, and India

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and
Pradeep Mitra

Applications of general equilibrium models to different problems arising in tax policy — such as identifying desirable tax bases in Bangladesh, analyzing price controls in China, and coordinating tax-cum-tariff reform in India — show how useful they can be in supplementing more qualitative judgments. But they are useful only if substantial effort is devoted to establishing a consistent data set and to choosing the structure of the model in a way that makes its behavior consistent with what good economic analysis would suggest.

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This paper — a product of the Public Economics Division, Country Economics Department — is part of a larger effort in PRE to develop techniques to help policymakers in developing countries identify the implications of different tax reform packages for revenue, efficiency, and equity. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Ann Bhalla, room N10-059, extension 37699 (46 pages, including tables).

While general principles can guide the design of the overall contours of a tax reform package, models for tax policy analysis can complement analysts' judgments in important and replicable ways. Dahl and Mitra show their usefulness with three examples.

They use a tax policy model for Bangladesh to show how one can analyze the revenue and incidence effects of a tax reform proposal of the kind that arises in country economic work. For each sector of the economy, the model is asked: how much must an ad valorem excise tax be raised in that sector to generate an additional one percent of *total* indirect tax revenue? The results show how the burden of tax increases in each sector is distributed across different rural and urban socioeconomic groups and how it affects such variables as the consumer price index and the trade deficit. Since each sector is asked to contribute the same amount of revenue, the results can be compared across sectors to show which of them are better candidates for increased taxation in an overall reform package.

The revenue and incidence effects are then combined in a single measure that allows one to rank the sectors by the efficiency-cum-equity cost of raising revenue. Those rankings are used to compare traditional with general-equilibrium-based approaches to incidence analysis, a comparison that underlines the importance of assumptions about the labor market and about substitutability in production in formulating tax policy proposals.

In their second example, Dahl and Mitra use a tax policy model based on data from China to examine the desirability of recommending broad uniformity of tax rates among sectors. Such uniformity may yield acceptable outcomes in market-based economies, but the model shows that losses from uniform taxation can be very significant in a decentralizing socialist economy — where some production is centrally planned and subject to price controls and some is subject to decentralized decision-making and transacted at market prices.

Their third example, drawn from an ongoing study in India, shows how two models — one sectorally disaggregated but macroeconomically simple, the other macroeconomically richer but sectorally aggregated — can be implemented on a common data base to help study the coordinated reform of tariffs and indirect taxes. The combined models can be used to calculate how much indirect taxes must be increased, after a reduction in tariffs undertaken to promote an outward-oriented development strategy, to produce enough revenue for the government to meet its expenditures without changing the current account deficit.

Finally, Dahl and Mitra discuss the costs of constructing general equilibrium models for tax policy analysis — and implications for data requirements and judgments about modeling strategy. The most effort must be devoted to (1) establishing a consistent data set and (2) calibrating the model in a way that allows its behavior to be consistent with what good economic analysis would lead one to expect. These costs must be set against the benefits of the modeling approach to tax policy analysis in developing countries.

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Bangladesh, China, and India

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Henrik Dahl and Pradeep Mitra

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APPLYING TAX POLICY MODELS IN COUNTRY ECONOMIC WORK: BANGLADESH, CHINA, INDIA

Henrik Dahl and Pradeep Mitra

SUMMARY

General principles can guide the design of the overall contours of a tax reform package to a considerable extent. Quantitative analysis, or a model, can however provide a useful supplement when it comes to examining specific proposals with respect to the two important dimensions of applied tax analysis, viz., revenue estimation and tax incidence. This paper draws attention to some of the ways in which tax policy models developed by PRE's Public Economics Division in the course of country economic work have been used to shed light on these questions.

The first part of the paper uses a tax policy model for Bangladesh to illustrate how the revenue and incidence effects of a tax reform proposal of the kind that can arise in country economic work may be analyzed. To that end the model is asked the question: what is the necessary increase in ad valorem excise taxes on a particular sector that will raise an additional 1 percent of total indirect tax revenue? This is done for each sector of the economy. Results are presented as to how the burden of tax increases in each sector is distributed across different rural and urban socio-economic groups and the impact on such variables as the consumer price index and the trade deficit. Since each sector is examined from the point of view of its effectiveness in contributing the same amount of revenue, the above results can be compared across sectors to allow a judgment to be made as to which of them are better candidates for increased taxation in an overall reform package.

The revenue and incidence effects noted above are then combined and summarized in a single measure that allows different sectors to be ranked with respect to the efficiency-cum-equity cost of raising revenue. These rankings are used to compare traditional versus general equilibrium based approaches to incidence analysis. This is done by ascertaining that would happen to the rankings first if, as is common in partial equilibrium incidence analysis, it were assumed that all tax increases are fully forward shifted into user prices, and if second, as is sometimes the case in partial equilibrium analysis, it were assumed that all tax increases are fully backward shifted into factor returns. Incidence judgments are more heavily influenced in the first case by the characteristics of the socio-economic groups that consume the product on which the tax is to be increased and in the second case by the characteristics of those employed in its production. The change in the rankings in the three cases: full forward shifting, full backward shifting and the "central" case of a combination of forward and backward shifting of taxes is considerable and highlights the critical importance of labor market specifications and substitutability assumptions in production in arriving at judgments about tax policy proposals.

The second part of the paper uses a tax policy model based on data from China to examine the desirability of recommending broad uniformity of tax rates over a large number of sectors. While such a rule of thumb leads to generally acceptable outcomes in market-based economies, it requires substantial re-examination in decentralizing socialist economies, such as China, where some production is centrally planned, and subject to price controls, and some is subject to decentralized decision-making and transacted at market prices. The planning authorities allocate certain inputs to enterprises and require the delivery of certain outputs; these transactions occur at controlled prices. However, enterprises may sell any

additional output (above that required by the plan) as well as purchase additional inputs (above those allocated by the plan) at market prices. Taxes on controlled price sales have to be borne by the enterprise and reduce investment, welfare facilities and bonuses. In contrast, taxes on free market sales can be passed on to the consumer and only harm the enterprise through a reduction in the demand for its output. The coexistence of forward shifting of taxes on market sales and backward shifting on price-controlled sales makes significant non-uniformity of tax rates desirable; this is because, with price controls, backward shifting would cause uniform tax rates to lead to highly unequal profitability and workers' bonuses across sectors. The China model is used to show that the losses from uniform taxation can increase rapidly with the extent of price controls. These losses are much larger than those computed in economies without such controls. This implies that while simplification of rates is desirable on administrative grounds and to reduce opportunities for rent seeking, a unification of value added tax rates is not appropriate in the presence of price controls. The exercise may also be seen as providing a strong argument for price reforms.

The third part of the paper, drawn from an ongoing study on India, pertains to the coordinated reform of tariffs and indirect taxes. Trade liberalization, recommended in the interests of promoting an outward-oriented development strategy, can, in the absence of offsetting fiscal measures, have negative consequences for revenue and, hence, macroeconomic stability. Tracing the consequences of tariff reductions on macroeconomic aggregates requires an aggregated model capable of incorporating economywide linkages. On the other hand, the language of tariff reform analysis is disaggregated and requires that the effects of policy changes be quantified in sectoral detail. These objectives are reconciled by implementing two

models on a common data ba : (i) a sectorally disaggregated version that makes simple assumptions regarding certain macroeconomic relationships and (ii) an aggregated version that makes more appropriate assumptions about those relationships and suggests what correction ought therefore to be made to the results of the sectorally detailed analysis. The approach is used to illustrate by how much indirect taxes need on average to be increased following a reduction in protective customs duties, so as to allow the government to meet its expenditures without any change in the current account deficit.

Finally, the paper discusses the costs of constructing general equilibrium models for tax policy analysis with reference to data requirements, demands on computing and judgements regarding modelling strategy. It is argued that establishing a consistent data set is among the costlier elements of modelling and that computing and software requirements are inexpensive by comparison. It is relatively straightforward to implement a model and to run policy simulations once the data base has become available. Considerations such as these must be set against the ability of models to complement the analyst's judgment and the gains made possible in terms of consistency of the recommendations and their potential for replication. To this must be added the fact that the models can yield "economywide" parameters, for example, estimates of the distortionary costs of the tax system, that are an useful input into sectoral and project decision-making outside the immediate context of tax policy. The various arguments are brought together to allow the reader to assess the costs and benefits of the modelling approach to tax policy analysis in developing countries.

APPLYING TAX POLICY MODELS IN COUNTRY ECONOMIC WORK: BANGLADESH, CHINA, INDIA

I. INTRODUCTION

General principles can guide the design of the overall contours of a tax reform package to a considerable extent. Thus, it is customary to recommend, for example, that the value added tax form the mainstay of the indirect tax system, that it apply to as large a part of the economy as administrative constraints permit, that it exempt nonmarketed food consumed by the poor and be supplemented by a luxury rate or excises on selected luxury items and on those goods whose consumption the government wishes to discourage. Turning to company taxation, the emphasis is on broadening of the base and neutral treatment of different sectors and alternative sources of investment finance. And the reform of personal income taxes focuses on the need for an exemption level that is consistent with administrative capacity, a small number of tax rates and elimination of special incentives that typically lose revenue rather than further the objectives that are described as justifying their existence.

While a number of developing countries have undertaken significant tax reform to varying degrees, the more usual situation is one where consideration is being given to changing certain taxes and their rates as part of budget making or planning exercises. In such situations, policy makers are interested in ascertaining the impact of the proposals on revenue and the way in which they would affect different socioeconomic groups. General principles alone are of limited use in such cases and it becomes necessary to undertake some quantitative analysis. This paper

reports on the use of three tax policy models developed by the Public Economics Division of the Policy Research and External Affairs (PRE) Complex of the World Bank to analyze this set of issues in the course of undertaking economic work with the regional departments in the Bank's Operational Complex. The first model, that for Bangladesh (Section II), is used to demonstrate how the relative attractiveness of different revenue-raising options depends sensitively on the workings of labor markets and substitution relationships in production, matters regarding which conventional partial equilibrium incidence analysis makes strong assumptions. The second model, that for China (Section III), emphasizes the importance of taking a systemwide view of taxation in a decentralizing socialist economy, where the coexistence of administered and free market prices for the same commodities can make standard tax reform prescriptions most inappropriate. The exercise highlights some of the links between tax reform and price reform. The third model, drawn from an ongoing study on India (Section IV), examines the kinds of domestic tax adjustments that would be necessary in the wake of reductions in import tariffs in order to allow the government to continue to meet its real expenditures without any change in foreign borrowing, but taking into account changes in the prices of intermediates and capital goods resulting from the tariff reform.

Section V of the paper discusses the costs involved in constructing and implementing tax policy models, sets them against the insights into policy made available by using models and provides a brief overall assessment. Section VI summarizes the principal findings of the paper.

II. BANGLADESH

Background

This section highlights the role of shifting assumptions in production and the operation of factor markets in influencing the choice of sectors that should be additionally taxed to raise a given amount of government revenue. The illustrations focus on excise taxation, a brief account of the characteristics of which follows.[1]

Attempts to reduce the economy's dependence on trade taxes which contribute over 50% of tax revenue have promoted increasing reliance on the excise tax which accounts for 97 percent of taxes on domestic production in Bangladesh. This is a turnover tax that is levied ex factory on domestic production and also on some services, and whose effects cascade throughout the whole economy. In recent years excise taxes have accounted for 23 percent of tax revenue. While the average rate of excise taxation, defined as the ratio of collections to the gross value of excisable production is around 8 percent, two-thirds of excise tax revenue is accounted for by three categories of goods, viz., tobacco, gas and petroleum-cum-oil-cum-lubricants.

Raising One Percent of Indirect Tax Revenue

As with any tax reform, a proposed change in excise taxation has two effects that are of interest to analysts and policy makers: (i) revenue and (ii) incidence across different socioeconomic groups. To isolate those effects, the Bangladesh tax policy model, which distinguishes 35 production sectors and 10 socioeconomic groups, is asked the question:

1/ A similar analysis with respect to other taxes in Bangladesh is contained in Dahl and Mitra (1989) to which the reader is referred for a fuller description.

what is the necessary increase in ad valorem excise taxation of a given sector which will raise an additional 1 percent of total indirect tax revenue (or Tk 230 million at 1984/85 prices) with government expenditure requirements (i.e., public consumption and investment) held fixed? The experiment is done for every sector and the efficiency and distributional effects of the changes examined.

Two points about these experiments deserve comment. First, to raise an additional 1 percent in total requires raising more than an extra Tk 230 million from the sector in question alone. This is because the direct and cascading-induced increases in market prices lead to a reduction in the level of activity, imports and hence import tax receipts that are not offset by the government disposition of the additional tax revenue; we shall return to this last point later. Second, the demand for an additional 1 percent of total indirect tax revenue at constant prices means that the results can be compared across sectors: in all cases, the government drain on the economy is the same. Thus, if the required increase of the excise tax rate is 1 percentage point in one sector, and 10 percentage points in another, it is immediately clear that the first sector is more readily able to raise revenue. It need not be the more preferable instrument, however, because its inherent welfare cost or its distributional consequences may be undesirable. The results are summarized in Table 1.

Column (1) shows the percentage increase in the ad valorem excise tax rate that will raise indirect tax revenue by 1 percent. Column (2) shows the resulting change in the consumer price index. Column (3) records the movement in the trade gap induced by the effect of excise taxation on imports and exports. Increases in tax rates transfer income from the private sector to the government which, with fixed public expenditure, has

Table 1. Bangladesh: Macroeconomic Effects of Raising One Percent of Real Revenue by Different Excise Taxes

	(1) Relative Increase in Excise Tax Rate (Pct.)	(2) Relative Increase in Consumer Prices (Pct.)	(3) Relative Increase in Trade Deficit (Pct.)	(4) Relative Increase in Excise Tax Revenue (Pct.)	(5) Relative Increase in CDST Revenue (Pct.)	(6) Distribution Effect (Sign)	(7) Relative Loss of SWF (Pct.)
Rice	0.18	-0.17	-0.39	3.31	-0.02	-	2.35
Wheat	2.73	-0.08	-0.37	3.31	-0.03	-	2.06
Jute	4.10	-0.95	-0.76	3.38	-0.05	-	4.79
Cotton	7.02	-0.14	-0.23	3.55	-0.13	?/-	1.38
Tea	16.57	-0.05	-0.11	3.27	-0.01	?/-	0.57
Other Crops	0.61	-0.19	-0.40	3.37	-0.05	?/-	2.25
Livestock	1.84	-0.20	-0.41	3.32	-0.03	?/-	2.19
Fisheries	0.99	-0.17	-0.38	3.31	-0.03	?/-	2.11
Forestry	2.72	-0.06	-0.13	3.38	-0.06	0	0.66
Sugar	3.50	-0.09	-0.26	3.53	-0.12	0/-	1.44
Edible Oil	2.82	-0.11	-0.36	3.41	-0.07	0/-	2.00
Tobacco	7.27	-0.10	-0.36	3.32	-0.03	0/-	2.41
Other Food	3.14	-0.15	-0.37	3.35	-0.04	0/-	1.77
Cotton Yarn	3.90	-0.24	-0.42	3.64	-0.17	0/-	2.45
Cloth	1.11	-0.10	-0.32	3.41	-0.07	0/-	1.87
Jute Textiles	2.04	-0.01	-0.03	3.26	-0.00	+	0.13
Paper	8.08	-0.16	-0.27	3.55	-0.13	0/-	1.51
Leather	2.91	-0.18	-0.33	3.31	-0.03	0/+	1.93
Fertilizer	2.98	-0.13	-0.38	3.33	-0.03	?	2.07
Pharm. & Chemicals	2.28	-0.12	-0.32	3.54	-0.13	0/-	1.68
Cement	11.13	0.03	0.01	3.47	-0.10	+	-0.03
Basic Mct. Is	1.85	0.01	0.01	3.73	-0.21	+	0.03
Metal Products	1.20	-0.01	-0.05	3.30	-0.02	0	0.23
Wood/Other Ind.	1.32	-0.06	-0.17	3.47	-0.10	0/-	0.84
Urban-HBldg.	8.78	-0.01	-0.04	3.27	-0.01	0	0.19
Rural-HBldg.	3.45	-0.00	-0.01	3.26	-0.00	0	0.07
Other Constr.	1.40	-0.01	-0.02	3.26	-0.00	0	0.09
Petroleum	0.48	-0.13	-0.35	3.41	-0.07	0/-	1.85
Electricity/Gas	3.32	-0.13	-0.20	3.39	-0.06	0/-	1.16
Transp. Services	1.11	-0.19	-0.37	3.40	-0.06	0/-	2.05
Housing	2.14	-0.16	-0.36	3.30	-0.02	0/-	2.02
Health	6.51	-0.07	-0.26	3.31	-0.03	-	0.88
Education	3.29	-0.04	-0.12	3.27	-0.01	0	0.46
Public Admn.	1.35	-0.01	-0.02	3.27	-0.01	0	0.11
Trade & Other	0.30	-0.20	-0.38	3.44	-0.08	-	2.03

a contractionary impact, resulting in a fall in the consumer price index and an improvement in the trade deficit. Columns (4) and (5) report the resulting changes in excise revenue and revenue from customs duties and sales taxes (CDST) on imports respectively.

The relative real incomes in the base year of the model (1984/85) of the socioeconomic groups identified by the Household Expenditure Survey are shown in Table 2. The numbers are presented as ratios to the economywide average, where the latter is weighted by the population in each group. The distributional impact of the excise tax changes of Table 1 are shown in detail in Table 3 which reports the impact on real income, i.e., income deflated by the consumer price index, for each socioeconomic group. An informal examination of those numbers is used to generate Column (6) of Table 1. Thus a plus (+) means progressive, zero (0) indicates neutrality, whereas a minus (-) indicates regressive incidence. A question mark (?) signifies that the outcome is unclear. While this information can (and will) be more formally presented, the detailed results of Table 3 are frequently of considerable interest to analysts and policy makers in identifying the main elements of a tax package. Such a package, once identified, can then be simulated using the model and its revenue and incidence impact examined in detail. Column (7), which may be disregarded

Table 2. Bangladesh: Base Per Capita Relative Real Income by Socioeconomic Group (Relative to Weighted Average Across Groups)

Landless Rural	0.915
Small Farmers	1.018
Medium Farmers (Tenants)	1.015
Medium Farmers (Owners)	1.079
Large Farmers	1.109
Largest Farmers	1.204
Rural Informal Sector	0.903
Rural Formal Sector	1.097
Urban Informal Sector	0.766
Urban Formal Sector	1.064

for the moment, reports the change in social welfare resulting from the tax change, using a social welfare function introduced later in this section.

Tables 1 and 3 show that a number of excise taxes feature desirable properties: they are effective at raising revenue, have little effect on the trade balance and may even exhibit progressive incidence. This is true, most notably, of the basic metals sector. The table also shows, for example, that while jute textiles is a satisfactory tax base, this is not the case for jute. This is mainly because, in contrast with jute textiles, jute is an intensive employer of the rural landless. It is also because jute is a smaller sector, so that a larger tax increase is necessary to raise the same revenue.

Underlying Assumptions of the Model

The tax policy model used for the above analysis makes the following assumptions.[2] First, household preferences are modelled using a linear expenditure system for each socioeconomic group. Second, supplies of primary factors are modelled as follows. In each of the urban and rural areas, supplies of primary factors are isoelastic in the real wage rate for all classes, except one. Members of the remaining class, termed the residual class (the landless in the rural area, the informal sector in the urban area) migrate freely into and out of other classes in the same area, thus providing a pool of labor which adjusts to demands for other types of primary inputs. When demands for other classes of factors increase, the residual class accommodates this demand pressure, thus reducing the supply

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2/ A more formal statement is contained in Dahl and Mitra (1989).

Table 3. Bangladesh: Per Capita Real Income Effects of Raising One Percent of Real Revenue by Different Excise Taxes
Effects by Socioeconomic Class

Sector	Landless	Small Farmers	Medium Farmers Tenants	Class Medium Farmers Owners	Large Farmers	Largest Farmers	Rural Informal Sector	Rural Formal Sector	Urban Informal Sector	Urban Formal Sector
Rice	-0.43	-0.08	-0.09	-0.10	-0.10	-0.11	-0.05	-0.04	0.22	0.02
Wheat	-0.36	-0.07	-0.08	-0.08	-0.08	-0.08	-0.05	-0.04	0.11	0.00
Jute	-0.88	-0.19	-0.15	-0.15	-0.14	-0.13	-0.01	-0.05	-0.04	0.05
Cotton	-0.25	-0.05	-0.07	-0.07	-0.07	-0.06	-0.05	-0.03	0.19	0.02
Tea	-0.11	-0.02	-0.03	-0.03	-0.03	-0.03	-0.02	-0.01	0.06	0.01
Other Crops	-0.43	-0.08	-0.11	-0.11	-0.11	-0.11	-0.06	-0.05	0.25	0.03
Livestock	-0.42	-0.09	-0.11	-0.11	-0.10	-0.09	-0.08	-0.05	0.23	0.01
Fisheries	-0.41	-0.07	-0.10	-0.09	-0.10	-0.10	-0.09	-0.07	0.23	0.03
Forestry	-0.14	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.05	0.09	0.01
Sugar	-0.29	-0.06	-0.07	-0.07	-0.07	-0.07	-0.04	0.03	0.12	0.01
Edible Oil	-0.37	-0.07	-0.09	-0.09	-0.09	-0.10	-0.05	-0.04	0.16	0.01
Tobacco	-0.44	-0.09	-0.11	-0.11	-0.11	-0.11	-0.06	-0.04	0.14	0.01
Other Food	-0.38	-0.08	-0.10	-0.11	-0.10	-0.10	-0.04	-0.03	0.20	0.02
Cotton Yarn	-0.42	-0.09	-0.12	-0.11	-0.11	-0.11	-0.09	-0.06	0.21	0.01
Cloth	-0.31	-0.05	-0.07	-0.07	-0.07	-0.07	-0.10	-0.03	0.08	0.00
Jute Textiles	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.00	-0.00	0.01	0.00
Paper	-0.31	-0.0%	-0.08	-0.08	-0.08	-0.07	-0.06	-0.03	0.20	0.01
Leather	-0.33	-0.07	-0.09	-0.09	-0.08	-0.08	-0.06	-0.04	0.19	-0.03
Fertilizer	-0.35	-0.07	-0.10	-0.09	-0.09	-0.08	-0.08	-0.06	0.11	-0.02
Pharm. & Chemicals	-0.33	-0.07	-0.08	-0.08	-0.08	-0.07	-0.07	-0.03	0.15	0.01
Cement	0.00	0.00	0.00	0.00	0.01	0.01	0.00	-0.01	0.03	-0.01
Basic Metals	-0.01	-0.00	-0.00	-0.00	0.00	0.00	0.00	-0.01	0.01	-0.02
Metal Products	-0.05	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.01	-0.00
Wood/Other Ind.	-0.18	-0.03	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	0.08	0.00
Urban House Bldg.	-0.03	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00
Rural House Bldg.	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00
Other Construct.	-0.02	-0.00	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	0.01	0.00
Petroleum	-0.36	-0.07	-0.09	-0.08	-0.08	-0.08	-0.06	-0.04	0.17	0.01
Electricity/Gas	-0.23	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.03	0.11	0.02
Transp. Services	-0.38	-0.08	-0.11	-0.10	-0.09	-0.08	-0.07	-0.04	0.20	0.01
Housing	-0.38	-0.07	-0.09	-0.09	-0.09	-0.10	-0.06	-0.05	0.19	0.02
Health	-0.19	-0.03	-0.04	-0.04	-0.04	-0.04	-0.05	-0.08	-0.11	-0.03
Education	-0.08	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.04	-0.08	-0.02
Public Adminis.	-0.02	-0.00	-0.01	-0.01	-0.01	-0.00	-0.00	-0.00	0.01	0.00
Trade & Other	-0.38	-0.08	-0.11	-0.10	-0.10	-0.09	-0.07	-0.05	0.20	0.01

of landless or urban informals. When the demands for other factors decreases, the numbers in the residual class increase.[3] When members of the residual household class migrate to other classes they are assumed to adopt the spending habits of their new class. Third, the primary factor inputs of each of the socioeconomic groups are aggregated (using a CES function) into value added in each sector.[4] Fourth, output is a Cobb-Douglas aggregate of intermediate inputs and value added.

These assumptions imply in general that a tax increase on a commodity, for example of the type considered in Table 1, would in part be shifted forward into increased prices paid by users of the commodity and in part be shifted backward into depressed returns to factors employed in its production. The degree of shifting is endogenous and determined, inter alia, by the relevant supply and demand elasticities for the commodity.

In contrast, it has been common in partial equilibrium work on developing country tax incidence to assume either (i) full forward shifting, where commodity taxes are fully reflected in changes in the corresponding consumer prices, with producer prices remaining constant,[5] or (ii) full backward shifting, where, for example, domestic commodity prices are anchored by world prices, corrected for trade taxes and subsidies, so that changes in those taxes are reflected in returns to factors employed in those sectors.[6] It is clear that the desirability of particular tax

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3/ Readers will recognize that this view of the labor market underlies the discussion in Little and Mirrlees (1974).

4/ It should be noted that the model does not include quasi-fixed sector-specific primary factors. This is due to the lack of data on capital in Bangladesh. Thus the wage rate actually refers to the price of value added.

5/ See Ahmad and Stern (1984), (1987).

6/ See Hughes (1986).

changes depends on the view adopted regarding incidence, which latter is influenced by assumptions made about shifting. Since tax analysts necessarily make such assumptions, whether explicitly or otherwise, it is of some importance to examine the sensitivity of judgments about desirable directions of reform to the range of shifting assumptions that have been used in the empirical literature.

The Agenda

To that end, we implement the following program. First, the revenue and incidence information of Tables 1-3 is summarized in a single measure that captures the relative desirability of increased taxation on a particular sector. Second, the underlying elasticities of the model are changed to reproduce the full forward and full backward shifting cases. Third, the summary measure is calculated for each sector for the full forward and full backward shifting cases. Fourth, the change in sectoral rankings is examined in order to assess the sensitivity of desirable directions of reform to shifting assumptions.

Step 1: A Summary Measure

A change in the tax rate on any good will affect government revenue and, through changes in the burden of taxation, the welfare of different socioeconomic groups. The loss caused to the socioeconomic groups per unit of revenue raised thus takes into account both revenue and incidence effects and provides a natural measure of the desirability of intensifying taxation on any particular sector. Of two sectors, the one with the lower (higher) loss per unit of revenue is a better (worse) candidate for taxation in the sense that, at the margin, a revenue-neutral switch from the worse to the better sector would be welfare-improving.

The model is used to calculate the effect on welfare and on revenue of a marginal (strictly, infinitesmal) increase in the excise tax on each sector, taking into account the general equilibrium interactions of that change. The welfare effect is then divided by the revenue effect to yield the measure described above.[7]

To aggregate the welfare affects across socioeconomic groups, we use the following social welfare function.

$$W = \sum_h N_h U_h^{\nu}/\nu$$

where

N_h: population of socioeconomic group h (h = 1 ...10)

U_h: per capita utility level of h (h = 1...10)

ν : index of inequality aversion ($\nu \to 1$)

We choose as the central case a value of -5 for ν, reflecting a degree of inequality aversion greater than that used in many exercises. A detailed justification for choosing such a value is provided later in this section.[8]

Step 2: Shifting Assumptions: Three Cases

In order to implement different kinds of shifting scenarios, a particular configuration of labor supply and substitution elasticities among factors is chosen as a "central case" and those parameters then varied to generate two polar cases: (i) full forward shifting and (ii)

7/ This is the general equilibrium analogue of the measure proposed by Ahmad and Stern (1984), (1987) in evaluating tax reform in the more partial context of full forward shifting.

8/ Column (7) of Table 1 presents the welfare loss arising from raising an additional Tk 230 million from each sector. It may be noted that this is a discrete rather than a marginal change.

full backward shifting. These cases, while polar, are not extreme: as mentioned before, both have featured in the empirical literature.

The "central" case, from which the results of Tables 1-3 were taken, is defined by labor supply elasticities of 0.5 for all socioeconomic groups and a uniform-across-sector elasticity of substitution of 0.5 among all primary factors in generating value added. Taxes are partly forward shifted and partly backward shifted in this case.

Full forward shifting obtains in the model when (i) all elasticities of substitution between factors are set to zero and (ii) the labor supply elasticities by socioeconomic groups are set to infinity.[9] These assumptions effectively allow the primary factors to be aggregated into a single factor, thus ensuring that no unit cost increases due to taxation may be shifted back into reduced factor returns.

Full backward shifting is achieved by setting all labor supply elasticities to zero. In this case, the supply of labor is constant, and any changes in labor demand lead to changes in the real wage rate. Thus, when taxes are increased, the demands for factor decrease, resulting in a lower real wage rate, with general equilibrium repercussions throughout the economy.

Step 3: The Ranking of Sectors

Table 4 ranks sectors with respect to the value of the marginal welfare-to-revenue ratio. As mentioned before, this has the interpretation that a revenue-neutral switch from a lower-ranked to a higher-ranked sector is welfare-improving. Before proceeding to the results, it should be observed that the welfare-to-revenue ratios will be affected by what assumption is made regarding the disposition of the revenue raised by the

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9/ In fact, to achieve numerical stability, they are set equal to 20.

government through taxation. The figures reported here are calculated on the assumption that the government saves the additional revenue raised through taxation, using it in part to retire foreign debt. An alternative assumption, viz., that the government invests the extra revenue subject to the current account deficit in the balance of payments being fixed, makes vary little difference to the rankings. These are reported in Dahl and Mitra (1989).

It is apparent from the table that the welfare-to-revenue ratios are widely dispersed across sectors. However, it is true under all shifting assumptions that cotton yarn, jute and tobacco are among the worse candidates for taxation. Desirable tax bases are rural housebuilding, other construction and public administration and, except for full forward shifting where cascading is strong, cement. It may be noted that housebuilding, construction and cement are linked together and serve investment needs (which do not yield immediate welfare effects in the static model).

A dramatic example of the impact of shifting assumptions on rankings is provided by the rice sector. This sector uses a high share of landless in its production. When taxes are backward shifted, income effects are strong for this group, which is both the poorest group in the country, as well as the labor reserve class for the rural area. Its ranking however climbs to 2 under full forward shifting. This is related to the fact that the supernumerary usage of rice in the linear expenditure system is not very progressive in income, thus yielding much smaller total distributional and income effects than if taxes are backward shifted.

Table 4. Bangladesh: Rankings by Welfare-to-Revenue Ratio of Marginal Changes in Excise Taxes by Sector

Sector	Central Case	Full Forward Shifting	Full Backward Shifting
Rice	10	2	14
Wheat	29	21	32
Jute	35	31	35
Cotton	21	25	21
Tea	12	17	12
Other Crops	15	11	22
Livestock	24	15	30
Fisheries	7	1	10
Forestry	13	19	13
Sugar	22	24	20
Edible Oil	28	29	28
Tobacco	33	34	34
Other Food	26	26	19
Cotton Yarn	34	35	33
Cloth	17	13	25
Jute Textiles	6	7	6
Paper	23	27	16
Leather	27	30	26
Fertilizer	14	12	18
Pharmaceuticals & Chemicals	25	28	23
Cement	1	6	1
Basic Metals	3	8	3
Metal Products	9	10	8
Wood & Other Industries	16	18	15
Housebuilding			
- Urban	8	9	7
- Rural	2	3	2
Other Construction	4	4	4
Petroleum	20	16	24
Electricity & Gas	19	22	17
Transport Services	32	23	29
Housing	30	32	31
Health	18	20	11
Education	11	14	9
Public Administration	5	5	5
Trade & Other	31	33	27

Another notable, though less striking example, is the basic metals sector which becomes a better candidate for taxation the greater the degree of backward shifting. This occurs because the sector only employs higher income classes (rural and urban informals and formals). On the other hand, when taxes are fully forward shifted, the basic metals sector becomes less attractive since the prices of many other using sectors are affected, thus increasing the cost of living for other household groups, including the landless.

Step 4: Sensitivity of Rankings to Shifting

The sensitivity of sectoral rankings to shifting assumptions is summarized in the Spearman rank correlation coefficients reported in Table 5 between the results obtained in each case. It is 0.79 for two economies that differ only with respect to the production and labor market parameters that affect tax shifting. This is quite a low number, considering that everything else in the two economies is identical.

Distributional Emphasis an Disaggregation

It will be recollected that the parameter ν was set at -5, reflecting a very strong degree of aversion to inequality. If instead we choose ν = -1, it is found that the rankings are highly correlated. From this, it is tempting to conclude that unless inequality aversion is very high, it is unnecessary for the analyst to take a particular view regarding substitutability assumptions in production and factor market conditions. However, as argued in Dahl and Mitra (1989), this would be a mistake, for the following reason. Taxation is in practice done at a level of classification that is significantly more disaggregated than that represented in this model, or indeed in most workable applied general equilibrium models where the degree of disaggregation is constrained by the availability of data. By taxing different goods that appear within the

Table 5. Bangladesh: Rank Correlation Coefficients Across Different Shifting Assumptions

	Excise Taxes
Full Backward Shifting - Central Case	0.943
Full Forward Shifting - Central Case	0.916
Full Forward Shifting - Full Backward Shifting	0.785

same sector in the model at different rates, it is possible to target selected households or income groups on the basis of differences in consumption and employment patterns more effectively than is represented here. Thus, the petroleum sector of the Bangladesh model includes heavy fuels, light fuels, kerosene and the like. The distributional characteristics of the groups consuming each of those products are different, a feature that is obscured in the model by the fact that all users are affected by a tax on petroleum. For the same reason, no account can be taken of differences among socioeconomic groups employed in the production of different commodities belonging to the same sector. The need to tax all commodities making up a "model" sector at the same rate may be viewed as a tax restriction. This imposes a constraint on the redistribution desired by even a moderately inequality-averse government (one with $\nu = -1$). To correct for the fact that the conduct of tax policy has, in practice, more degrees of freedom than may be represented by the model, it was decided, for modelling purposes, to take a higher degree of inequality aversion than that expected to be characteristic of a government.

The above view about the tradeoff between aggregation and the redistributive potential of commodity taxation was confirmed by aggregating the 35-sector model into 5 sectors and observing that the sectoral rankings were almost perfectly correlated even for $\nu = -5$. This finding confirms that even moderate redistributive concerns are enough to make shifting assumptions matter, the greater the degree of sectoral disaggregation. In practice, the number of commodities and sectors is very large and the resulting classifications facing tax policy makers very disaggregated, thus highlighting the need for careful attention to the underlying determinants of shifting in incidence analysis.

Implication for Tax Policy Analysis

The analysis with the Bangladesh tax policy model has shown that judgments on desirable directions of tax reform based on revenue-cum-incidence analysis can be quite sensitive to the modelling of the degree of substitution among factors in production and on the conditions prevailing in factor markets in the economy.[10] Moreover, this conclusion applies to comparisons between different model specifications that, far from being extreme, implicitly underpin the shifting assumptions actually used in partial equilibrium-based empirical work.

Given our uncertainty about the true values of some of the underlying elasticities, models such as the one developed here should be used to identify revenue-raising tax packages that are broadly satisfactory for plausible rather than polar values of the elasticities, an approach implemented in Mitra et. al. (1989b).

10/ The demand system is kept constant in these experiments. Sensitivity of the rankings to changes in demand systems is examined in Dahl and Mitra (1990).

III. CHINA

The Problem

As in a large number of other countries, the value added tax (VAT) is assuming increasing importance in the indirect tax system in China. The VAT rates are, however, decided on a product-by-product basis with rates set to yield broadly the same revenue as the turnover tax replaced by the VAT, although there are some goods, such as textiles, that have seen a reduction in their tax burden. This means that there is a large number of VAT rates, as reported for broad groups in Table 6.

Faced with this situation, a standard recommendation made by tax analysts is to unify the VAT rate across all the sectors that the tax administration is able to reach, with the rate set to generate the same revenue as that raised before unification.[11] Would such advice be appropriate in an economy such as China?

Institutional Structure

To help answer this question, is it necessary to sketch the institutional framework within which the tax system is embedded.[12] The two following features are particularly important.

First, economic reforms in China have led to the introduction of the so-called dual pricing system that allows State enterprises to purchase part of their inputs and sell part of their output at market prices. However, State enterprises must first deliver their plan quota at

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11/ To this would be added supplementary excises or a luxury rate of VAT on selected goods on distributional grounds.

12/ For a fuller discussion, see Mitra, et. al. (1989a).

Table 6. China: Value Added Tax Rates on Major Product Groups

Product Group	Rate
Textiles	14% - 23%
Clothing and footwear	14% - 20%
Enamel products	20%
Glass and glass products	14% - 26%
Medicines	14%
Household Machinery	14% - 43%
Electrical appliances	14% - 20%
Electronic appliances	12% - 16%
Machinery	12% - 14%
Steel	8%
Steel products	14%
Paper	14% - 30%
Stationery	12% - 30%
Household chemicals	14% - 45%
Ceramics	12% - 30%
Processed food and beverages	14% - 30%
Leather	14% - 20%
Furniture	14%

controlled prices (known as State list prices) before selling output on the free market. To allow this, such enterprises may also buy inputs necessary to fulfill plan targets at controlled prices.[13] The system of price controls is an implicit subsidy to users, financed by an implicit tax on producers. Thus, for example, price controls on final goods subsidize final consumers at the expense of consumer goods-producing enterprises, while price controls on intermediate goods boost profitability in consumer goods-producing enterprises at the expense of those producing intermediate goods.[14] Since indirect taxes must operate within the overall framework of

13/ It is estimated, for example, that the proportions of agricultural products, consumer goods and intermediate goods not transacted at controlled prices in 1986 were 76 percent, 53 percent and 40 percent respectively. See Mitra, et. al. (1989a).

14/ Thus, an illustrative calculation suggests that the effect of price controls on nonagricultural final goods is to reduce the index of retail prices by around 7 percent. See Mitra, et. al. (1989a).

price controls, it is necessary to view taxes and price controls as constituting an integrated system.

Second, before the economic reforms, State enterprises received all funds for expansion from the State, and, in return, remitted all profits to the State. The reform process introduced so-called profit responsibility, which replaced profit remittances with enterprise income taxes. The enterprise was allowed to keep its after-tax profits and to divide them between three alternative uses: (1) investment and research and development; (2) workers' welfare fund; and (3) wage bonuses.

Controlled prices could however lead to highly unequal profitability of enterprises in different industries. This would produce large divergence between enterprises in the amount of after-tax profits they could devote to the three uses. In order to prevent this, commodity taxes[15] (which had only been of minor significance before the reform) are set at different rates for different industries.[16]

The coexistence of the two sets of prices has significant implications for tax policy analysis. Taxes on controlled price sales have to be borne by the enterprise and reduce investment, welfare facilities and bonuses. In contrast, taxes on free market sales can be passed on to the consumer and only harm the enterprise through a reduction in the demand for its output.

15/ Originally, the commodity taxes were the Product Tax and the Business Tax. These are both turnover taxes and are gradually being replaced by the Value Added Tax.

16/ The use of taxes to equalize profitability could be avoided by setting the controlled prices to just cover cost (including any taxes that might be desired for other reasons), and by revising them regularly to reflect cost changes. However, the available evidence from China, and other countries with controlled prices, suggests that this usually does not happen.

VAT: Simplification or Unification?

Difficulties with tax administration and opportunities for wasteful rent-seeking imply that considerable simplification is desirable in the structure of VAT rates in China. However, since the existence of price controls has a very significant effect on profitability,[17] unification of the VAT rate structure without price reform would be premature.

A tax policy model based on Chinese data was used to explore the losses that would arise from unifying VAT rates in the presence of controlled prices for plan transactions and free market prices for other transactions.[18] The model distinguishes twenty-four production sectors and assumes that inequality arises from differences in workers bonuses caused by backward shifting of taxes on that portion of sales occurring at controlled prices.[19]

17/ Some estimates are provided in Mitra et. al (1989).

18/ For a fuller exposition and other details, see Heady and Mitra (1990a). It should be noted that the input output table used in this exercise is for 1981 and is therefore somewhat out of date. While this affects the numbers in Table 7, it does not affect the basic argument of this section.

19/ This assumption is made to provide income inequality as a simple representation of the harm caused by unequal profitability. If, instead, unequal profits produced unequal investment, long-run inefficiency might result. However, given the increasing liberalization of capital markets in China, debt financing might be used as an alternative to retail profits. In this case, unequal profitability will not produce unequal investment, but the allocation of current profits to investment will reduce future interest payments on debt and lead to larger future bonuses. Thus, all profits eventually benefit workers through bonuses or the size of the workers welfare funds.

Table 7. Welfare Losses (in GDP Equivalents) from Uniform Taxation and from Planning Logarithmic Social Welfare Function ($\epsilon = 0$)

	No Plan	1/4 Plan	1/2 Plan	3/4 Plan	Full Plan a/ (a)	(b)
Welfare loss from uniform taxes	0	0.8%	3.7%	8.6%	15.4%	
Welfare loss from planning	0	1.2%	2.7%	3.8%	4.6%	5.9%

a/ The results in column (a) are calculated on the assumption that enterprises can make up short output by purchasing on the free market. The results in column (b) rule out this practice. There is no welfare loss from uniform taxes in column (b) because uniform taxes and full planning are inconsistent with market clearance.

Table 7 demonstrates the welfare losses (measured in GDP equivalents) (i) from imposing uniform taxes in a semi-planned economy and (ii) from planning. The loss is measured as the percentage reduction in income that would have produced the same reduction in social welfare. The social welfare function used in the calculation is, as before, of the form:

$$W = \sum_h N_h U_h^{\nu}/\nu$$

where N_h: employment in industry h

U_h: utility function of a worker in industry h

ν: index of inequality aversion. ($\nu \to 1$)

We take $\nu = 0$, whence the above reduces to

$$W = \sum_h N_h \log U_h$$

The first column gives the results when there is no planning, as a benchmark for comparison. With an assumed inelastic labor supply, uniform taxes are optimal in this case. The second column presents the results where, for each sector, the planned inputs and planned outputs are

equal to one quarter of their 1981 values and plan prices are the same as in 1981. The remaining columns correspond to increasing the plan quantities, always as a uniform proportion of the 1981 inputs and outputs. At all levels of planning up to and including 3/4, sectors all produced more than the plan quantities. However, when planning was increased to cover the whole of the 1981 inputs and outputs, some sectors wished to produce more and some less.[20] There were then two assumptions that could be made: (a) that enterprises could produce less than the plan and purchase the difference at free market prices,[21] or (b) enterprises had to adhere strictly to the plan, and so there was no production for the free market. Columns (a) and (b) under "Full Plan" correspond to those two alternatives.

Inspection of Table 7 shows that the loss from uniform taxation increases rapidly with the extent of planning. In other words the degree of differential taxation increases with planning. The reason for this is that planning introduces inequality in profits and bonuses, and so some of the efficiency in the goods market must be given up to reduce income inequality. In the final column, there is no efficiency reason affecting tax setting because output is fixed at the plan levels. In this case, taxes are being used entirely to equalize profitability between sectors. It is worth noting that the losses from uniform taxation are large compared to losses computed in free market economies.[22] Table 7 shows that even the planning of only a quarter of output produces significant

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20/ They could not all produce more because the labor constraint was set equal to the 1981 labor use.

21/ In that case some goods would be counted twice in the plan: once when originally produced, and again when bought by another enterprise and sold to the planning authority.

22/ See, for example, Ebrahimi and Heady (1988).

losses from uniformity, a result that continues to be true with a more modest degree of inequality aversion such as $\epsilon = 0.5$.[23]

Finally, as planning is a distortion in this particular model, the welfare loss arising from this source goes up with its extent, as seen in Table 7.

While the losses from imposing uniformity are substantial, it would be inappropriate to recommend, for example, that any country adopt a VAT with many different rates, given administrative costs and attendant opportunities for tax fraud and rent seeking. Instead, the results should be seen as providing strong evidence that considerable welfare losses could occur if tax rates were equalized before substantial price reform is undertaken, a result that is reflected in the more institutionally-oriented discussion in Mitra, et. al. (1989a). A sensible compromise between the stark simplicity of the model and the reality of the tax system might be to divide goods into perhaps three groups with a "low", "standard" and "high" rate of VAT. Other simulations with the model show that the introduction of three groups with separate tax rates captures at least two thirds of the gains that would be made in moving from uniform to sectorally differentiated taxation.[24]

Tax Reform and Price Reform

Given the practical difficulties of administering a highly differentiated tax system, the numbers presented here may be seen as providing a measure of the desirability of price reform. More generally, the framework helps illuminate the importance of seeing the tax system and its reform in the context of other reforms and of making clear that

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23/ See Heady and Mitra (1990a).

24/ See Heady and Mitra (1990b).

recommendations on tax policy necessarily depend on what is assumed about other policy changes in the economy.

IV. INDIA

The Problem

The move towards an outward-oriented development strategy, with its attendant benefits, requires lowering tariffs and quantitative restrictions on trade. However, many developing countries rely on tariffs to a significant extent to raise public revenue.[25] Thus, while conversion of quantitative restrictions into tariff equivalents would be revenue-raising, the reduction of tariffs could be expected to be revenue-reducing. In what follows, we draw on preliminary findings from an ongoing study to examine the kinds of fiscal adjustments that would be required to offset tariff reductions in India, a country where import duties as a proportion of imports were 63% in 1987/88.[26]

In common with many other countries, tariffs in India comprise (i) a protective element (known as basic and auxiliary customs duties) and (ii) a purely revenue-raising element (known as the additional or countervailing customs duty, CVD) that matches the domestic excise tax.

25/ The World Development Report 1988 estimates that the contribution of import taxes to public revenue is over 20% in Asia, sub-Saharan Africa and in the Middle East and North Africa compared to 2% in the industrial countries.

26/ See Mitra and Go (1990). The effect of relaxing nontariff import licensing will also be the subject of that study. Available evidence, quoted in Kishor (1989), suggests that the premium on import replenishment licenses given to exporters had fallen to around 5% in the 1980s, largely due to a shift to a more active exchange rate policy and increased tariffs on imports. However, such licenses cannot be used to import goods on the so-called restricted list.

The CVD and the central excise tax are subject to the modified value added tax (MODVAT). Table 8 reports the contribution of the various taxes to the revenue of the Union (the Central government) and that of the Union and States.

The table shows that protective customs duties account for a high proportion - 31% of Union revenues. Hence reduction of those duties may be expected to have a significant impact on the public finances and would require offsetting policies, most likely with respect to excise taxes-cum-CVD.[27] Assessing those budgetary consequences and estimating the magnitude of those changes require a framework that incorporates the appropriate economywide linkages. On the other hand, the categories used in tariff reform analysis are sectorally disaggregated, so that it is necessary also to ascertain how the economywide changes traced above would affect, for example, various subsectors within the manufacturing sector. These objectives are reconciled by implementing two models on a common (1987/88) data base: (i) a 72-sector disaggregated version that makes simple assumptions regarding certain economywide relationships and (ii) an aggregated 6-sector version that makes more appropriate assumptions about those relationships and suggests what correction ought therefore to be made to the results of the sectorally detailed analysis.

This approach can be used as follows. The disaggregated model assumes, for ease of computation, that the real returns to primary factors such as capital and various types of labor are fixed at their base year levels or, equivalently, that the factors are in perfectly elastic supply at those real factor prices. These factors combine with

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27/ It is important that the adjustment be made to both the excise as well as the CVD which matches the excise tax. The argument is spelled out in Mitra (1990).

Table 8: India: Composition of Indirect Tax Revenue a/ 1987-88

	Imported Goods	Domestic Goods	Total
	A. Union		
Protective Import Duty	31.23		31.23
Countervailing Import Duty	4.10		4.10
Union Excise Tax	-	43.64	43.64
Total	35.33	43.64	78.97
	B. Union and States		
Protective Import Duty	23.57		23.57
Countervailing Import Duty	2.74		2.74
Union Excise Tax		29.11	29.11
State Excise Tax		4.61	4.61
State Sales Tax a/	0.84	18.59	19.43
Total	27.15	52.31	79.46

a/ Figures are percent of total tax revenue.

intermediate inputs, both domestic and imported, to produce domestic output. The latter, in turn, is subject to import competition under various licensing arrangements for certain kinds of intermediates and capital goods and, reflecting the Indian situation, to no such competition for consumer goods. Incomes are paid to a single average rural and single average urban household and are then divided between consumption and savings. Exports depend on the ratio of export prices to those of substitutes in international markets as well as income in the rest of the world. The government collects tariff and tax revenue from intermediates, capital and final goods and spends on public consumption: the difference is public savings which, together with private savings and the excess of imports over exports (or, foreign savings) finances investment.[28]

28/ For details, see Mitra and Go (1990).

The Indian economy is characterized by a budget deficit of around 10% of GDP and a current account deficit of over 3% of GDP. To calculate the magnitude of the adjustments required to support tariff reform, the model is asked the question: by how much do excise taxes and CVDs need on average to be increased for a given across-the-board reduction in protective customs duties, so as to allow the government to finance its expenditures without any change in the trade deficit?[29]

The Agenda

The question is answered in the following stages. First, the required average increase in taxes is calculated in the 72-sector model under the assumption that real returns to factors are held constant at their 1987/88 values. Second, the responsiveness of the required average increase in taxes to changes in the real factor prices is calculated, again in the 72-sector model. Third, the 6-sector model, with flexible real factor prices, is used to determine the impact of an across-the-board cut in protective tariffs on the real returns to labor and capital. Finally, the change in factor prices (step 3) is multiplied by the responsiveness to factor prices (Step 2) to adjust the estimates in step 1.

Step 1: Required Tax Change: Disaggregated Model

The macroeconomic effects of an across-the-board reduction in protective customs duties are as follows. Investment and government expenditures are held constant in real terms, so that the behavior of the model will be seen to exhibit certain "Keynesian" features. A decrease in

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29/ The increase in excise taxes is confined to the nonagricultural sector, as the contribution of agriculture to excise tax revenue is only 0.03%.

tariffs has a negative effect on public revenue and, since government consumption is fixed in real terms, on public savings. However, given that around 60% of imports are inputs into the production process, a tariff reduction has a favorable effect on output, private sector incomes and hence, private savings. But since only a fraction of extra private sector income finds its way into private savings, the increase in the latter is less than the decline in public savings. With a given trade deficit (foreign savings), total savings in the economy decline and notwithstanding the tariff reduction-induced fall in investment goods prices, are not sufficient to finance investment expenditures. Since with fixed expenditures, the government saves all additional income, whereas the private sector saves only part of its additional income, domestic savings may be increased by transferring income to the public sector by increasing excise taxes-cum-CVD. With real returns to primary factors fixed, it is estimated in the 72-sector model that a 1% across-the-board cut in protective tariffs would call for an 0.48% increase in excise taxes-cum-CVD.

It may be noted from Table 8 that excises and CVD accounted for 48% of Union revenues in 1987/88 or, roughly one-and-a-half times as much as protective duties. Hence, it would have been tempting to conclude that an approximately 0.67% increase in excise taxes-cum-CVD would be necessary to offset the impact of a 1% reduction in protective tariffs. This, however, takes no account of the fact that the fall in prices induced by the tariff cuts reduces the cost of government expenditure and hence requires less revenue to be raised.

The tariff reduction-cum-tax increase with an unchanged trade deficit leads to an 0.14% increase in total imports and an 0.19% increase in exports.

Step 2: Responsiveness to Factor Prices: Disaggregated Model

An increase in real factor prices, by boosting aggregate demand, has an expansionary impact on the private economy, with a positive effect on income, consumption and savings. While this increases the value of fixed investment expenditures, the rise in private savings is larger and, using the arguments developed above, requires a reduction in taxes to transfer income to the government. It is calculated that the adjustment required in excise taxes-cum-CVD as a result of a 1% average increase in nonagricultural real wages and a 1% average increase in nonagricultural real returns to capital is negative and equals -6.4% and -2% respectively.

Step 3: The Effect on Factor Prices: Aggregated Model

The aggregated model maps the 72 sectors into 6 sectors but allows factor prices to be determined endogenously. Labor is mobile across sectors and is supplied with an elasticity of 1.2, except, as in the Bangladesh model of Section II, for the residual labor classes in the rural and urban areas. There is a bigger change in the treatment of capital, which is taken to be sector specific, so that its rate of return is residually determined, an assumption polar to that made in the 72-sector model. A cut in protective tariffs has been argued before to be expansionary, so that the pull of demand raises real factor prices. Since capital is supplied inelastically in each sector, its average real return is bid up to a greater extent. The aggregated model shows that a 1% across-the-board cut in protective tariffs has a negligible impact on nonagricultural real wages while raising nonagricultural real returns to capital on average by 0.09%.

Step 4: Required Correction to the Disaggregated Model

The previous two sets of calculations may now be put together to determine the correction required in the 72-sector model on account of the

assumption of constant real factor prices. The change in both sets of factor prices yielded by the 6 sector model, as a result of a 1% across-the-board reduction in protective tariffs (step 3), multiplied by the responsiveness of the adjustment factor for excise taxes-cum-CVD to changes in those factor prices (step 2), shows that the latter adjustment factor falls by roughly 0.2% for a 1% reduction in protective tariffs. This should be subtracted from the figure of 0.48% arrived at in the 72-sector model with constant factor prices to yield 0.28% as the average adjustment factor.

Summary

The two models together therefore show that the order of magnitude of the average upward adjustment to excises-cum-CVD varies from 0.28% to 0.48% in response to a 1% across-the-board cut in protective tariffs depending on what assumption is made about the elasticity of supply of capital to each sector. To recapitulate, the tariff cut raises real factor returns; the greater the effect on factor prices, the less the savings - investment gap that needs to be made up by increasing taxes.

V. IMPLEMENTING TAX POLICY MODELS

The models presented above have been shown to be capable of addressing a broad range of questions in a consistent way. These benefits must of course be placed against the costs that are incurred in their construction. This section describes some of those costs and concludes with an overall assessment.[30]

30/ For a detailed account of how a model can be implemented, see Dahl (1987), which reviews the necessary steps in the context of a particular model.

The costs of building and running a general equilibrium model for tax policy analysis may usefully be assessed by considering the phases of a model's "life cycle". Although the phases are not disjoint, the following breakdown is convenient for our purposes: (1) selection of model structure, (2) compilation of a raw data base, (3) model implementation, (4) generation of a consistent data base, (5) model calibration and (6) experimentation with the model.

Selection of Model Structure

The formulation of the problem at hand determines the structure of the model in a straightforward way. For instance, the evaluation of excise taxes requires a fairly disaggregated description of the production structure, while income tax analysis may call for closer attention to be paid to income generation, transfer incomes and the determinants of factor supplies and demands. Studies of trade taxation naturally call for a detailed description of foreign trade.

Compilation of a Raw Data Base

The structure of the model makes clear what data are required, whence the compilation of a raw data base may begin. This is a time consuming task. A typical model requires statistics on production, factor employment and income, demand patterns, foreign trade, government revenue and expenditure. The data comes from diverse sources. National accounts, aggregate foreign trade statistics and government revenues and expenditures are usually easily obtained. An increasing number of countries have household expenditure surveys and many have input-output tables that can be updated using other information. Employment and income statistics are harder to obtain, especially when sectorally disaggregated information is needed. In particular, it is normally not possible to get

reliable estimates of land use and capital stocks which must be "guesstimated," for example, by postulating plausible capital-output ratios. While it would clearly be desirable to collect time series of such data in order to get parameter estimates for use in the model, it is generally the case that the most important pieces of information are only available for at most only a few years.

Model Implementation

Once a raw data base has been put together, it becomes possible to decide on the size and structure of the model to be implemented. This will typically represent a compromise between the desired level of sophistication as chosen in the first step above and data availability.

Till only a few years ago, model implementation was a major activity which required a great deal of knowledge of computer programming, data base organization, and solution algorithms. The advent of modeling languages has changed this significantly. Today it is a rather straightforward matter to translate formal mathematical relationships into computer statements. For instance, the General Algebraic Modeling System, GAMS, in which all three models of this paper have been implemented, allows the user to input a model in virtually the same way as he would write it mathematically. A compact algebraic notation also means that formally similar equations for different sectors can be written as a single statement. This implies, for example, that even models as large as the one for Bangladesh which contains around 2500 equations and variables can be written in less than two pages. They may also be solved on a portable PC 386. The modeling languages have, furthermore, made possible a separation of model formulation and solution algorithm, a fact that makes it easy to alter the formulation without the modeler having to make corresponding changes to several thousand lines of solver code.

In addition, there are several prototypical models available today, which may be used as a template for the formulation of new models. Although each model must focus on the specific issues that it is designed to illuminate, most models share accounting identities and equilibrium conditions which may be taken over without much editing. These developments make it possible for the modeler to concentrate on the important tasks of describing behavior and the particular institutional structure of the economy.

Generation of a Consistent Data Base

Model implementation makes clear in which format data will be used. The next step is to work through the raw data base to produce a set of data that is specific to the model and consistent with its framework.

This is a major task. The raw data base will typically contain some data for one year and other pieces of information for another year. Sector and commodity groupings tend to differ among the input-output table, the household expenditure survey, and foreign trade statistics. Different data sources often use different definitions for households and labor groups. These need to be brought together to produce data for a base year (and preferably for more years) with common definitions of sectors, commodities, labor categories, households and other entities identified by the model.

Once data have been adjusted to match common definitions it is usually found that different pieces of data are mutually inconsistent. For instance, supplies and demands do not match for a given sector, or the savings-investment identity does not hold. Since general equilibrium models must account for all flows in a consistent manner, it becomes necessary to adjust parts of the data to produce a balanced set of numbers. Although algorithms (such as the RAS) are available for this

purpose and are easily implemented on a spreadsheet or in a programming language, they tend to give equal credibility to all data entries and are therefore too mechanical to produce sensible results. It is therefore essential that modelers identify the relatively more and less reliable parts of the data base so as to be able to decide what to adjust and what to keep unchanged.

Model Calibration

With the model-specific data base in place, calibration can begin. The purpose is to produce a set of parameters that will make the model reproduce the base year, and make it possible to track actual economic performance over several years. While existing procedures allow for considerable automation, the time consuming part of the exercise is to ensure that the calibration assumptions are chosen appropriately, i.e., in a way that allows the behavior of the model to be consistent with what good economic analysis would lead one to expect. Since general equilibrium models embody simultaneous interactions, this requires a deep degree of understanding of the structure and properties of the model.

Experimentation with the Model

Running experiments with the model, once it has been sensibly calibrated, is not usually very difficult or time consuming. The reason is partly that existing modeling languages allow for parameters to be changed readily for counterfactual what-if analysis, in addition to making it fairly simple to change behavioral assumptions.

Equally important from the point of view of the experiments reported earlier in this paper, some modeling systems such as GAMS allow optimization to be done on the model. This has two important uses. First, it enables optimal policies to be calculated, as in the China model, and permits comparison of optimal policies with other alternatives,

such as the uniform value added tax. Second, the optimization feature makes it possible to find general equilibrium multipliers and elasticities. The reason is that even while solving a model with as many unknowns as equations, and thus involving no optimization, as is the case with the Bangladesh and India models, the algorithm calculates shadow prices on all constraints in the model. Thus, for example, some of these constraints could be that various excise tax rates are fixed at their current values. If the objective function provided to GAMS is the social welfare function, the shadow price on a tax constraint has the interpretation of being the welfare cost of changing that tax instrument, allowing for all other changes that would occur to preserve general equilibrium. These features have been extensively used in the experiments reported earlier with the Bangladesh and India models.

Overall Assessment

Much though not all the data that needs to be collected for general equilibrium tax policy models is often put together anyway for various other purposes in country economic and sector work. The use of a model can impose some discipline on what needs to be done. In addition, however, very substantial effort must be devoted both to making the data base consistent as well as to calibrating the model in ways that make its behavior accord with more *a priori* views of the functioning of the economy which it purports to represent. This has two important implications. First, it requires that modelers be familiar with the way in which the data are put together, so that they may make informed judgments about the relative strengths and weaknesses of the different pieces of information in generating a consistent data base. Second, it requires that the analyst understand the behavior of his (or her) own model very well so that judicious decisions are made with respect to calibration. Lack of such understanding will also prevent the analyst from explaining why

results from policy simulations come out the way they do. Since knowledge of the data and the model do not, unlike solution algorithms, lend themselves readily to automation, the model will ultimately only be as good as the people available to work on it.

The examples of the paper indicate what kind of benefits may be derived from modelling exercises. First, they allow an extensive range of questions to be addressed. Examples provided here included detailed assessments of tax proposals, the sensitivity of revenue-cum-incidence analysis to assumptions about production structures and labor market specifications, the appropriate design of tax policy in the presence of dual pricing and the coordinated reform of tariffs and indirect taxes. These examples are clearly not meant to be exhaustive and many more questions could be analyzed using these approaches. Second, the range of results available are an useful input into sectoral and project decision-making outside the immediate context of tax policy. Thus, to give an example, raising Tk. 1 in Bangladesh of revenue through excise taxation imposes an additional economic cost over and above the revenue raised of between Tk. 1 and Tk. 2, depending on the particular tax that is raised. This information proved useful in assessing the costs and benefits of levying tolls as opposed to raising revenue through taxation in financing certain transport projects. Third, existing modelling languages allow the entire operation to be well-documented, thereby allowing results to be replicated by other policy analysts.

In conclusion, it may be noted that the average fixed costs of constructing tax policy models are lowered and the exercise rendered more cost-effective, if the models are used on a continuing basis for policy analysis rather than if they are "one-off" efforts. Thus, the Bangladesh model, in addition to being used for tax policy analysis in the Bank's tax

study, has been transferred, at the country's request, to the National Board of Revenue. The China model, in addition to being used for tax analysis, will be extended in an ongoing study on price reform. The development of the India model is at an early stage compared to the other two, but is expected to be adapted for an investigation into related sets of issues.

VI. CONCLUSIONS

This paper has described three sets of applications of tax policy models developed by the World Bank's Public Economics Division during the course of economic work on Bangladesh, China and India.

The Bangladesh model was used to highlight the role of shifting assumptions in influencing the relative attractiveness of different options for raising revenue. To that end, revenue and incidence effects of tax changes were combined and summarized in a single measure that allowed different sectors to be ranked with respect to the efficiency-cum-equity cost of raising revenue. Those rankings were used to compare traditional versus general equilibrium based approaches to incidence analysis. This was done by ascertaining what would happen to the rankings first if, as is common in partial equilibrium incidence analysis, it were assumed that all tax increases would be fully forward shifted into user prices, and if second, as is sometimes the case in partial equilibrium analysis, it were assumed that all tax increases would be fully backward shifted into factor returns. Incidence judgments were more heavily influenced in the first case by the characteristics of the socioeconomic groups that consume the product on which the tax is to be increased and in the second case by the characteristics of those employed in its production. The change in the rankings in the three cases: full forward shifting, full backward shifting and the "central" case of a combination

of forward and backward shifting of taxes was considerable, a finding that underlined the critical importance of labor market specifications and substitutability assumptions in production in arriving at judgments about tax policy proposals. Attention was drawn to the importance of identifying revenue-raising packages that are broadly satisfactory for plausible rather than polar values of the underlying elasticities.

The China model examined the desirability of recommending broad uniformity of tax rates over a large number of sectors. While such a rule of thumb leads to generally acceptable outcomes in market-based economies, it requires substantial re-examination in a decentralizing socialist economy such as China, where some production is centrally planned, and subject to price controls, and some is subject to decentralized decision-making and transacted at market prices. Taxes on controlled price sales have to be borne by the enterprise and reduce investment, welfare facilities and bonuses. In contrast, taxes on free market sales can be passed on to the consumer and only harm the enterprise through a reduction in the demand for its output. The coexistence of forward shifting of taxes on market sales and backward shifting on price-controlled sales smakes significant non-uniformity of tax rates desirable; this is because, with price controls, backward shifting would cause uniform tax rates to lead to highly unequal profitability and workers' bonuses across sectors. The model showed not only that the losses from uniform taxation increase rapidly with the extent of price controls but also that those losses are much larger than those computed in economies without such controls. This implies that while simplification of rates is desirable on administrative grounds and to reduce opportunities for rent seeking, a unification of value added tax rates is not appropriate in the presence of price controls. More generally, the exercise underlined the importance of

viewing the tax system and its reform in the context of reforms in other areas of the economy.

The India model focussed on aspects of the relationship between trade liberalization undertaken to reduce anti-export bias and tax reform viz., the need for tax increases to offset potential revenue losses arising from reduction of tariffs in an economy where the latter make a substantial contribution to public revenue. This was done using two models implemented on a common data base: (1) a disaggregated version that made simple assumptions regarding certain economywide relationships in order to focus on the consequences of tariff reform for various subsectors, and (2) an aggregated model that made more appropriate assumptions about those relationships and suggested what corrections ought therefore be made to the results of the sectorally detailed analysis. Together the models were able to illustrate by how much indirect taxes need on average to be increased following a reduction in protective customs duties, so as to allow the government to meet its expenditures without any change in the current account deficit. The required adjustment in taxes was shown to be quite different from what an inspection of the shares of taxes and tariffs in public revenue alone might have suggested. The difference was due to the fact that price decreases induced by tariff reductions led to a fall in the value of the same real expenditures and hence reduced the amount of revenue that needed to be raised.

Finally, the paper briefly described the costs of constructing tax policy models with respect to data requirements, demands on computing and judgments regarding model structure and calibration. It was argued that the two most important and time-consuming elements arose from the

need to generate a consistent data base and to calibrating the model in ways that made its behavior accord with more a priori views of the functioning of the economy which it purported to represent. The former requires knowledge of the relatively more and less reliable parts of the data base while the latter requires the analyst to understand the structure of the model so as to be able to explain why results from policy simulations come out the way they do. These costs must be weighed against the fact that the models are capable, as shown in this paper, of addressing an extensive range of questions, and of doing so in a consistent and potentially replicable way. Moreover, some of the results generated are moreover useful in sectoral and project analysis that transcends the immediate context of tax policy. The average fixed costs of constructing tax policy models are seen, not just as "one-off" efforts, but as tools for use on a continuing basis for policy analysis.

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